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Reusable Launch Vehicle Development Research

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Reusable Launch Vehicle Development Research

1.0 OBJECTIVE

1.1 Background

The National Space Transportation Policy states that "The National Aeronautics and Space Administration will be the lead agency for advanced development and demonstration for the next-generation reusable space transportation systems, such as the single-stage-to-orbit concept.....Research shall be focused on technologies to support a decision no later than December 1996 to proceed with a sub-scale flight demonstration which would prove the concept of single-stage-to-orbit." The policy also states, "Technology development and demonstration, including operational concepts, will be implemented in cooperation with the Department of Defense."

The development and operations of a single-stage-to-orbit (SSTO) reusable launch system is anticipated to be accomplished with significant private sector involvement. To prepare for this, the National Space Policy states that the "U.S. Government agencies will pursue commercial space transportation activities without the use of direct federal subsidies." Innovative types of arrangements between the U.S. Government and the private sector, as well as State and local governments must be identified and promoted. These ideas include such concepts as "anchor tenancy" by the government for space launch services in which the government guarantees a certain base of business for the privately operated launch system.

1.2 Scope of Work

NASA has generated a program approach for a SSTO reusable launch vehicle technology (RLV) development which includes a

follow-on to the Ballistic Missile Defense Organization's (BMDO) successful DC-X program, the DC-XA (Advanced). Also, a separate a sub-scale flight demonstrator, designated the X-33, will be built and flight tested along with numerous ground based technologies programs. For this to a successful effort, a balance between technical, schedule, and budgetary risks must be attained. The adoption of BMDO's "fast track" management practices will be a key element in the eventual success of NASA's effort.

2.0 TASK OVERVIEW

GPS Solution's staff have been involved in the DC-X program since it's inception, assisting in the evaluation of the early design studies, technology development, flight test and range operations. GPS Solutions, Inc. has also been involved in interagency support and has continued to assist the Department of Defense in the development and execution of "fast track management" to other programs. GPS Solutions, Inc. will apply the past technical and programmatic "lessons learned" to this research effort to assist NASA/MSFC to produce a successful SSTD RLV program.

To support the above objectives under the contracted effort, the following four Tasks were addressed during this initial thirteen (13) week effort:

Task 2.1: Evaluation of Industry Involvement in RLV Development and Operations

Task 2.2: Interface with Aerospace Associations

Task 2.3: RLV Program Assessment from Non-Program Office Perspective

Task 2.4: RLV Program Presentation

The details of these Tasks are discussed in the following sections. This report is the beginning of more in depth research to be done throughout the follow-on efforts. This final report represents an interim snapshot of the on-going investigations

2.1 Evaluation of Industry Involvement in RLV Development and Operations

2.1.1 Task Description

"The contractor shall identify development and operations options for both a next generation reusable launch vehicle (RLV) and precursor sub-scale flight demonstrator. To support the implementation of the National Space Transportation Policy, this shall include review and analysis of a range of options from those requiring private investment only to those that require NASA and/or DoD to perform some degree of the development and direct federal funding"

2.1.2 Approach

Historically, the majority of launch vehicle development and supporting ground and space based operations have been paid for and developed under Government direction and guidelines. This was acceptable and possible because of the Golden Rule, the Government had the gold to spend on these development efforts. The days of the Government pushing a design for a space shuttle and having the contractor build the vehicle and infrastructure to Government specifications appear to be behind us.

Today, U.S. civil space transportation policy, and particularly the question of whether and how we move to a "next generation" SSTD RLV system(s), is both a microcosm and the leading edge of what is belived to be an imminent revolution in U.S. civil space program.

If we extrapolate the premise that the Government will not fully fund a new commercially viable SSTD RLV system, that leaves only two options: a jointly funded (Government and industry) SSTD RLV system: or a privately funded SSTD RLV system.

This section of research will begin with broad background policy strategy issues and then will funnel down to focus on the investigation of past government subsidized or jointly funded programs.

2.1.3 Policy Strategy

In crafting a strategy for pursuing a commercial SSTD RLV system, NASA is in effect choosing a strategy for its own future. That is why the SSTD RLV problem is so challenging, and why there is a natural tendency to ignore strategy and focus on tactical and operational questions. In seeking an enduring result with the private sector, NASA must abandon command-economy thinking as well as behavior to effectively embrace market-economy assumptions and approaches.

This mindset-shift boils down to the following: NASA must ultimately give up control of space transportation and put its faith in the ability of competitive free markets to foster private ventures which will develop and operate the space access infrastructure for public and private customers, including NASA itself.

This is not to say NASA will no longer have a role in space transportation. But its roles will be contextual in nature, rather than controlling and dominating. As is so often the case in leading large enterprises, instead of trying to directly manage performance, NASA's effective course will be to guide, frame, and "coach" the other participants in achieving their goals.

Given all of this, NASA's SSTD RLV strategy should include two necessarily distinct elements:

- o Government as Market Facilitator and Regulator
- o Government as Market Leading Customer

First and foremost, NASA must lead the government in fostering a market in space transportation services. This would also include working with other government agencies to encourage the transformation of today's raw demand and supply into a market which can evolve in directions which serve all space transportation customers, not just the government, and, not just in the U.S..

Second, NASA should understand its position as a market-leading customer and work with other current and prospective space customers. One example of this is buying technology demonstrations of capabilities the government will want to buy commercially, such as the X-33, instead of directly managing the development and/or procurement of new operational systems.

2.1.4 Commercialization Mechanisms

Suprisingly, there is no traditional "toolbox" of ways in which government can assist a new privatization venture to succeed. At the same time, creating a solid framework for economic activity is one of the most important social roles of government. So it is important to create some means of classifying all of the potential different mechanisms.

Government efforts to assist industry can be divided into two fundamental classes: structural and financial. Structural mechanisms refer to government's role in macro undergirding the creation and maintenance of free markets in goods and services, including its normal participation in those markets. Financial mechanisms are means by which government intervenes in narrow, specific markets to achieve positive market evolution.

Any NASA plan for applying these mechanisms to a prospective SSTD RLV industry would therefore need to focus on creating a healthy market environment for this emerging industry, including some limited financial stimulation.

The X-33 program is a dramatic stimulation...a "jump starting" of the process. But the success of the the U.S. space transportation industry in building on this momentum will depend greatly on how positive the market environment is for private innovation.

And as economist Robert Shapiro of the Progressive Policy Institute has stated: "the only force we know that drives innovation is competition" ("The Visible Hand," National Journal, July 9, 1994). Therefore, while NASA's historical role has been to directly drive innovation itself in the launch vehicle industry, now government will merely encourage innovation by creating as broad and competitive marketplace as possible, and then being a non-threatening, but smart, customer in that market place.

"better" (i.e. more stable and profitable but less competitive) route system for private passenger travel. By 1934, this led to charges in congress of a "spoils system" in contracting, and the political outcry led to re-socialization of Air Mail carriage under the Army. Several accidents led in turn to re-privitization, but with a break-up of the private carriers and separate regulation by what became the Civil Aeronautics Board ("Air Transport," Encyclopedia Americana, 1992, Vol. 1)

The lesson seems to be that a government created competitive market can work as long as government acts as a smart customer: seeking the best value it can for the public dollar but not micromanaging suppliers.

2.1.4.1.2 Marketplace Creation

Sometimes markets are easier to foster when you establish a physical (or virtual) marketplace where the market can operate. The obvious example is the local farmers market, which overall raises farm income and lowers food prices (or raises quality of dollar spent) for consumers.

In the space access market, this could be achieved by creating a special office in the General Services Administration (or some other administrative, non-mission agency) that would act as a broker for the government's demand for launch services and negotiates (on behalf of the individual agencies) with launch providers.

But for reasons of increased price and service competition, a broader, privately operated marketplace would be preferable. The obvious example is the New York Stock Exchange or other financial markets. In this case, a private entity is granted certain charter rights to operate (and self-regulate) a marketplace where buyers and sellers can seek optimum returns. Deals struck within the Exchange are granted some regulatory relief (eg. the different requirements on individuals owning publicly traded vs. no-traded stocks) while the Exchange is forced to regulate trades in other ways (eg. standards for stocks that can be listed).

2.1.4.1.3 Market Standardization

Market standardization refers to the government's use of its purchasing power or regulatory authority to create standards within

an industry for performance and/or service. Until now, NASA and the Air Force have created various standards for launch services by controlling or dominating the supply of those services.

With NASA shifting to the role of a customer, it can exercise considerable influence on the "standards" by selecting functional requirements for a SSTD RLV system. The danger is that NASA managers, who are used to overseeing the provider rather than simply buying something, will set too-specific or unnecessary requirements, and therefore unproductive (and even destructive) standards for industry to meet.

2.1.4.1.4 De- (or re-) regulation

One major structural changes brought on by a shift from launch provider to launch services purchases will be a transition from NASA as self provider and regulator to NASA as a regulated customer. The SSTD RLV industry will need a much more streamlined regulatory structure than current ELV systems.

As a major launch market customer, NASA will benefit from reform of existing regulations, both in cost savings and greater ease of market entry by new providers. Hopefully, as the launch industry grows to meet increased demands by lower prices, NASA, as a customer, can work with other customers and providers to decrease unnecessary DOT/OCST regulations.

2.1.4.2 Financial Mechanisms

Unlike structural approaches, financial mechanisms for government assistance to industry tend to narrower, more targeted changes or corrections to markets. These can range in scope and budgetary cost from industry wide stimulation of production to specific government provider transactions.

Government economists break these mechanisms down into three categories based on how they work (Congressional Budget Office, Federal Support of U.S. Business, 1984):

- o Direct Expenditures
- o Credit Programs

o Tax Expenditures

Direct expenditures refers to the spending of funds by the government to benefit one or more companies, as opposed to normal government consumption of an established good or service. These include direct payments to private ventures, funding research and development. (Ibid)

Credit programs are direct loans or loan subsidies (such as loan guarantees) by the government to producers or consumers of publicly beneficial goods or services.

Tax expenditures are the various forms of exceptions to normal tax rules granted by the government to groups of taxpayers, including specific industrial sectors or companies engaging in beneficial activities. In the case of U.S. businesses, these include exclusions of some portion of income from taxation, special credits against tax liabilities, and preferential tax rates for certain kinds of levels of income (Ibid. and Senate Budget Committee, Tax Expenditures, 1992).

What follows is a presentation and discussion of several different kinds of financial mechanisms which could supplement market incentives in achieving a successful commercial SSTO RLV industry.

2.1.4.2.1 Research and Development

Government R&D spending in concert with industry is a well understood way of helping specific industries lower costs and/or increase capability. One of the best historical models for this is the technologies, expertise and facilities given by NACA to the infant U.S. aircraft industry. It may be feasible to create an ongoing NACA like effort within NASA out of the X-33 program, with a strong emphasis on government solving industry problems.

2.1.4.2.2 Payments and Prizes

Historically, the government has offered individuals and companies a special payment in cash and/or tangible assets (such as land) for the achievement of some desired goal, especially if they were the first to do so. Sometimes these were in the form of a single

prize for a specific invention, and sometimes there have been open payment arrangements for all or part of the cost.

In the well known case of the Pacific Railroad Act of 1862, the government provided both land grants and cash incentives to five separate private ventures, who built, or more precisely, completed, transcontinental railroads. Various homesteading acts provided low-cost land purchases to farmers who won full title upon several years of land "improvement".

The first commercially successful SSTO RLV system will earn the "prize" of the lion's share of the government market (assumption), so such a special payment would seem redundant. Beyond direct payments and awards to SSTO RLV ventures, there are seemingly unlimited possibilities for payments and prizes for space-based activities which buy launch services from SSTO RLV ventures.

2.1.4.2.3 Anchor Tenancy

Anchor tenancy is one of the most familiar financial mechanisms that has been discussed within the space community. Examples include Space Industries' Industrial Space Facility, Boeing's offer to privately develop logistics modules for Space Station Freedom, and SpaceHab's Commercial Middeck Augmentation Module for the Shuttle. Of course, the first two of these were failures and the third has had an especially turbulent history.

Historically, problems with government anchor tenancy go back at least to the Air Mail contracts' example previously discussed. The tendency over time seems to be that providing a significant guaranteed demand to one provider either creates an artificial market that can't exist (let alone be profitable) without that subsidy.

2.1.4.2.4 Pricing

In the case of space access, the government can take three different positions on pricing for launch services. One frequently discussed mechanism is the payment of a premium price for launch services where other launch customers pay less for a similar services. A second approach is government can deliberately choose to set a new, "reasonable", cost level which it would fix for an extended period of time. Another approach is the government can promise to

pay some fixed cost, perhaps even the existing commercial price for any given market segment, for a short period of time, after which the government will pay new average market price.

2.1.4.2.5 Loan and Loan Subsidies

Several federal government programs provide credit to domestic and foreign borrowers through direct loans and subsidies to loan providers. The subsidies to lenders can range from offering a guarantee against all or part of the loan to paying an interest differential (Congressional Budget Office, op. cit.).

Examples of direct loans include several farm credit programs, rural electrification, disaster assistance, and the Export Import Bank's loans to purchasers of high value U.S. goods, such as Boeing 747's and Cray supercomputers. In the first case, loans are made for both land and equipment purchases and farm operation, often with reduced interest rates and flexible repayment schedules and to borrowers who would not qualify for normal business loans.

Government loan subsidies also vary, from guaranteeing an entire loan, thus the interest rate/or downpayment or collateral requirements below market levels, to directly paying part of a loan's interest charges to a private lender.

One particular kind of loan guarantee that has been discussed as an approach in helping one or more commercial SSTO RLV ventures is the corporate version of low-interest disaster assistance loans, typically called bailout loans.

Of these, the most often referred to is the Chrysler Corporation Loan Guarantee Act of 1979. This program was extremely large, \$1.5B in federally guaranteed principal plus \$1.43B through leveraging non-guaranteed loans and other funds, such as asset sell-off and employee concessions. It involved establishing an oversight board which issued the loan guarantees according to various requirements including Chrysler's Business performance against government inspected rolling four year operations plan (United States Congress, Public Law 96-185, 1980).

What many prospective SSTO RLV providers see in the Chrysler model is a deal that was so big that the government could not let Chrysler fail. Once the loan guarantees began, Chrysler was assured that the government policy wouldn't change and allow it to fail. Interestingly, the RLV communities interest is due to it's political

strength, a high profile national commitment to make an important industrial venture requiring an unprecedented peacetime partnership among government, business and labor.

2.1.5 Task Summary

Based on this preliminary research and discussions with several other space policy professionals, there may be no really good or historical models relevant for the privatization of a SSTO RLV system. Most recent examples of successful industrial policy are situations where government helps an established industry to serve its current customers, which is not the case here.

But, some major technological development and commercialization programs have failed, including synthetic fuels, both the U.S. and European supersonic transport, and Space Shuttle based space commercialization. In each case, policymakers tried to force public goals upon markets that were not prepared or able to implement them.

2.2 Interface with Aerospace Associations

2.2.1 Task Description

"The contractor shall identify the interest/concerns of traditional aerospace associations and their associated states/companies with respect to the impact of an RLV on the space launch industry. Feedback/information shall be obtained directly from these associations in order to understand both the positive and negative impacts of a new reusable launch system to their respective interests. This shall include the development, demonstration and operational phases of the program"

2.2.2 Approach

The initial group visited on this Task was the Aerospace States Association (ASA). GPS Solution, Inc. personnel attended there Quarterly meeting held at NASA Lewis Research Center on December 12 and 13, 1994.

2.2.3 Aerospace States Association (ASA)

The ASA is a national organization is a collection of thirty five (35) Lieutenant Governor's or there designees. The goal of the ASA is to advocate strong, competitive and viable U.S. aerospace commerce. The Association also works to preserve and increase U.S. aerospace employment, and support initiatives that enhance science and math education. Also, the ASA advances the concept of fuller participation by the states in federal aerospace policy information and implementation, and is a valuable source of information and political support for the development of aerospace-related program. Appendix XX contains more detail about the back round and activities of this organization.

It should be noted this organization has been a national forum to discuss SSTO RLV issues. Dr. Jack Mansfield, NASA AA for Code X, has been involved in several previous forums when he employed by Congress, to discuss SSTO options.

2.2.4 Task Summary

The ASA should be kept aware and up-to-date about the activities within the SSTO RLV program. This organization could assist in informing individuals within and outside of their states about the overall commercial impact of a SSTO RLV system. ASA has been very supportive of the SSTO RLV program from it's inception to increase U.S. competitiveness and increase space commerce.

2.3 RLV Program Assessment from a Non-Program Office Perspective

2.3.1 Task Description

"The contractor shall compile comments and perspectives from aerospace, commercial, DoD and other sources on NASA/MSFC's implementation of the RLV program. This version of external Total Quality Management shall assist NASA/MSFC in evaluating the RLV program and shall assist in achieving program continuity."

2.3.2 Approach

GPS Solutions, Inc. access to the internal development of the NASA RLV program is an unique situation. As mentioned in Section 1.1, GPS Solutions, Inc. personnel have a strong background in "fast track management" with the latest program being the BMDO DC-X program. The technical management skills learned-on that program have been enthusiastically supported on the follow on DC-XA program. NASA/MSFC's previous efforts to get a NASA policy waiver so industry could count IR&D as in-kind support initially for the NASA Research Announcements (NRA), and now the Co-Operative Agreement Notices (CAN) was, and will continue to be, critical to industry's support of this joint approach.

At a top level perspective, the implementation of GPS Solutions, Inc. declarative recommendation's to programatticly integrate all the potential aerospace, commercial, DoD and other government agencies up front and often, to make them part of the **solution**, and not a part of the problem, has been most rewarding.

Due to the immediacy of developing a new NASA approach to conducting business in a timely manner, the majority of the critique and feedback actions on this Task were done in real time.

2.3.3 Implementation of National Space Transportation Policy

The promotion of innovative types of arrangements between the U.S. Government and the private sector was included in the recently released National Space Transportation Policy. The use of innovative type of arrangements with industry has focused NASA on new approaches to doing business.

The current NASA approach is to be partners with industry and to jointly develop and cooperate on a new sub-orbital X-33 vehicle. This X-33 vehicle will be designed, built and flight tested with the goal of demonstrating reduced technical risk of building an operational SSTO RLV system. It is envisioned that by demonstrating reduced technical risks, and low cost operations on the X-33, the follow on SSTO system could be fully funded by industry investment.

The ultimate goal of the NASA Administrator, Mr. Dan Goldin, is to totally privatize the launch industry, thereby allowing NASA to focus it's efforts on breakthrough research.

The development of the "NASA Implementation Plan of the National Space Transportation Policy" document was a agonizing experience for NASA and the White House. GPS Solutions, Inc. personnel were instrumental in providing interface with the DoD and industry during this process. GPS Solutions, Inc. was also involved in writing, and rewriting, at least twelve (12) different versions of this document. Although the process was long and frustrating, it was also very fruitful. This was because both NASA and the Executive Branch (both the White House Office of Science Technology and Policy (WHOSTP) and the Office of Management of Budget (OMB)) recognized they must alter past practices, and possibly some laws, to achieve the goal of privatizing the launch industry.

2.3.4 Industry Interface and Business Planning

These efforts began initially when it was decided the X-33 program would be a joint Government/industry effort through the use of a Co-Operative Agreement. GPS Solutions, Inc. was involved in the initial Government/industry business meetings to discuss what aerospace companies would need to potentially invest their own, and/or investor's money, in a X-33 vehicle and/or follow on launch vehicle.

At the same time the contractors were made aware that they had to present a definitive, supportable business plan to NASA with the Co-Operative Agreement proposal. As a partner with the Government, industry would have to ensure the Government there was a market which would support a new RLV system, and, they could obtain financing to help them develop the vehicle for this market. To our knowledge, this is the first time these types of direct, meaningful discussions have been had between NASA and industry on a new way of doing business.

Initially the only answer was "anchor tenancy", which means the Government would purchase a number of launches (number to be initially proposed by the contractor, then negotiated with the Government) on the new SSTO RLV system. This approach has pro's and con's from both Government and industry perspectives, and were discussed in Section 2.1.4.2.3. Since these early meeting's, other options have evolved, and will be discussed in detail by the industry teams when they turn in their Co-Operative Agreement Proposals in the not too distant future.

2.3.5 Who's the Client?

A new business understanding is underway at NASA and was highlighted in the initial business meetings. Historically, NASA has been the client and has paid industry for hardware and services. With Mr. Goldin's goal of privatizing the launch industry, and now NASA being an equity partner with industry, the client for the X-33 program and beyond is **not** NASA, but industry.

GPS Solutions, Inc. approach in supporting NASA's efforts in RLV program continuity and development has been to continually ask, "Who's the Client?". This has assisted NASA on numerous occasions in cutting short discussions and focusing on issues at hand.

2.3.6 Co-Operative Agreement Notice (CAN) Development

The use of a Co-Operative Agreement (joint funding and joint responsibility, with industry being the program manager, after industry team(s) convinced NASA their approaches are feasible) was the selected strategy for initial 15 month X-33 studies. The CAN is scheduled to be released in mid-January (1995). The critical philosophical area in the development of the CAN was again, a new, flexible way of doing business.

NASA has historically provided detailed specifications to industry and had them provide services and build hardware. This CAN took a different approach. Besides the strong emphasis on business planning for a new SSTD RLV system, what the CAN will provide the industry teams is a minimum set of performance goals for the X-33 system, and give industry the opportunity and freedom to develop detailed specifications, designs and different ways to achieve performance goals.

2.3.7 Task Summary

GPS Solutions, Inc. has been involved at all levels of SSTD RLV system development in assisting NASA in both new technical and programmatic ways of doing business. GPS Solutions, Inc. will carry forward this approach into Option 1 of the contracted effort.

2.4 RLV Program Presentation

2.4.1 Task Description

"In order to more effectively convey the RLV program objectives within the Government and private sector, the contractor shall present the results of research conducted in the previous tasks in a format that shall include, but not be limited to layouts, renderings, detailed physical and computer models, hypermedia presentations and video displays using state-of-the-art visual technology. This shall include RLV technology and operational concepts identified in previous tasks."

2.4.2 Approach

Throughout the continuing development of the SSTO RLV program, the use of visual images is helpful in explaining and discussing conceptual ideas. Currently, John Frassinota & Associates is providing these images through the construction of data sets and subsequent 3D computer aided design (CAD) models.

2.4.3 3D CAD Model Development

The following detailed CAD models were developed and the following baseline renderings were produced and displayed in Figure 1.:

- o DC-X Liftoff
- o McDonnell Douglas (DC-3) SSTO Satellite Repair Mission
- o Winged SSTO
- o Lockheed Lifting Body SSTO

From these original 3D CAD models, other renderings were produced as photo-realistic images are shown in Figure 2:

- o Four (4) Views of Lockheed Lifting Body SSTO
- o Four (4) Views of Winged SSTO
- o Four (4) Views of McDonnell Douglas Vertical Landing SSTO
- o Winged SSTO Tandem
- o Winged SSTO Ground Transportation
- o Winged SSTO Launch Position
- o Horizontal Manned Payload (cutaway)
- o Launch Couch (close-up)

Other photo-realistic images are displayed in Figure 3:

- o Troika
- o Winged SSTO Hubble Repair #1
- o Winged SSTO Hubble Mission #2
- o Lockheed Lifting Body SSTO at Station
- o Winged SSTO Hubble Repair Close-up
- o Liftoff
- o SSTO Satellite Repair Mission
- o Winged SSTO Cargo Loading

All of the above mentioned 3D model images and associated data sets have been delivered to NASA/MSFC separately.

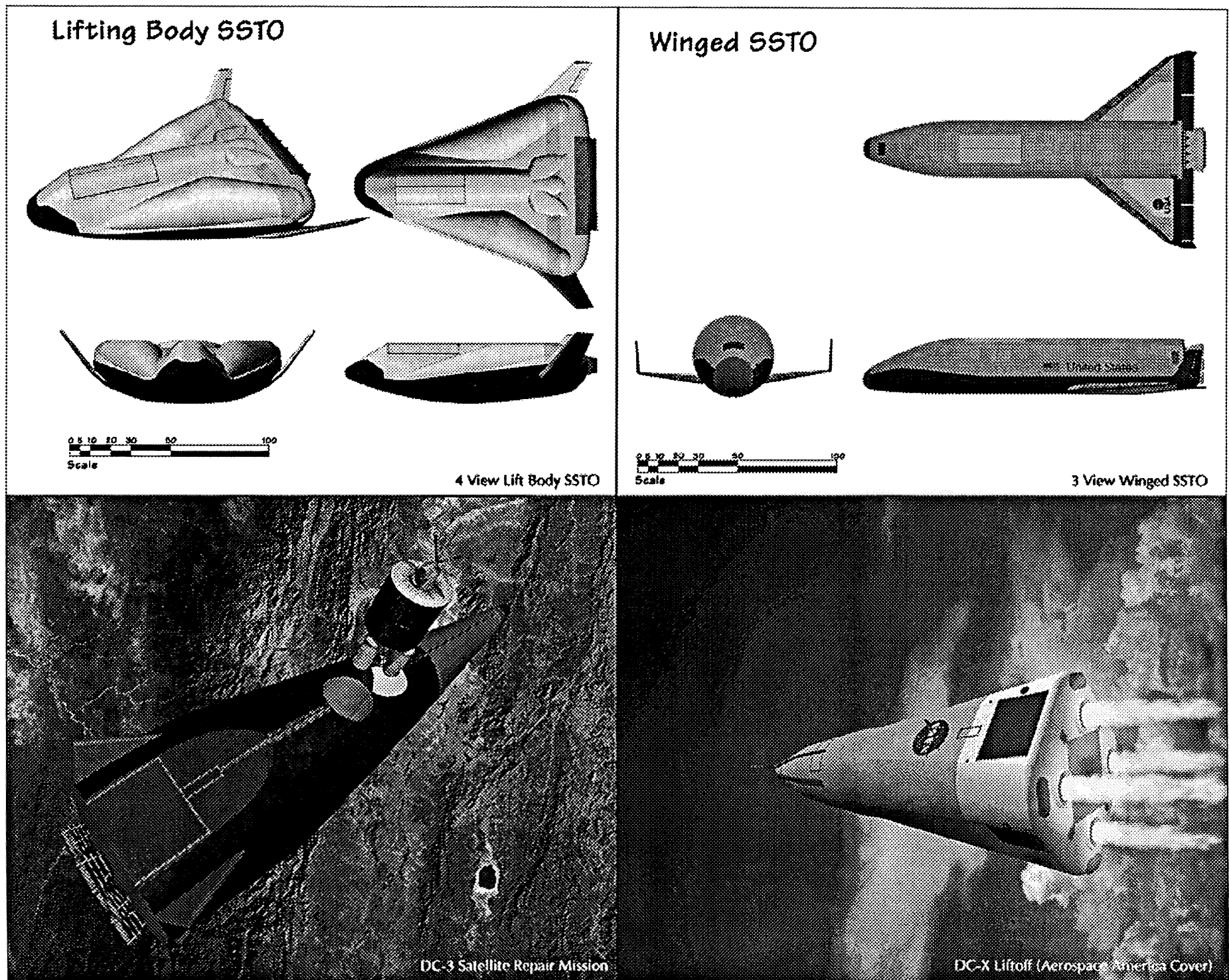
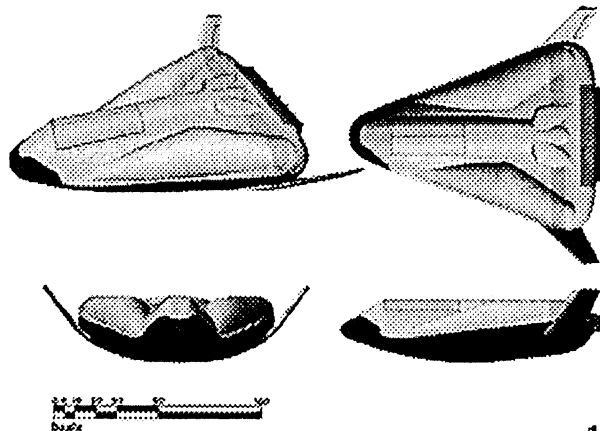


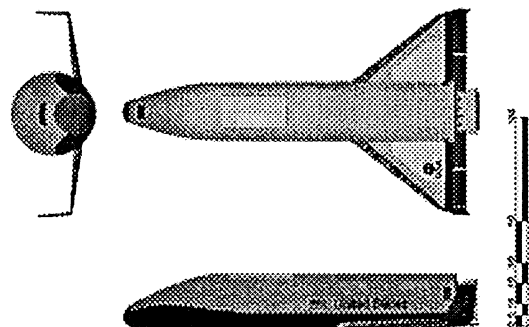
Figure 1. Photo-realistic Images

Lifting Body SSTO



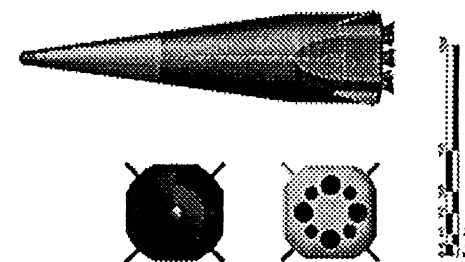
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Winged SSTO

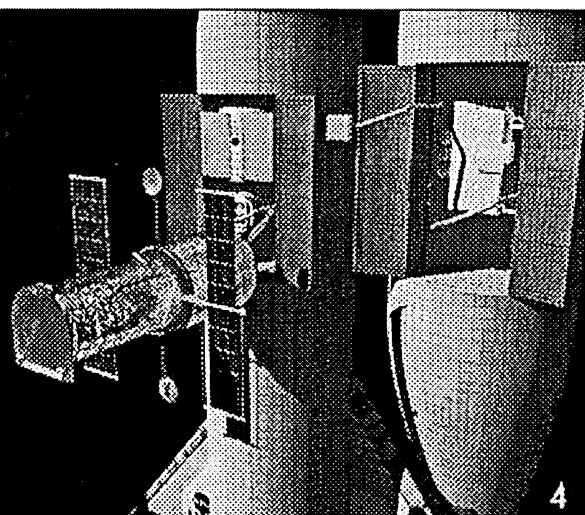


2

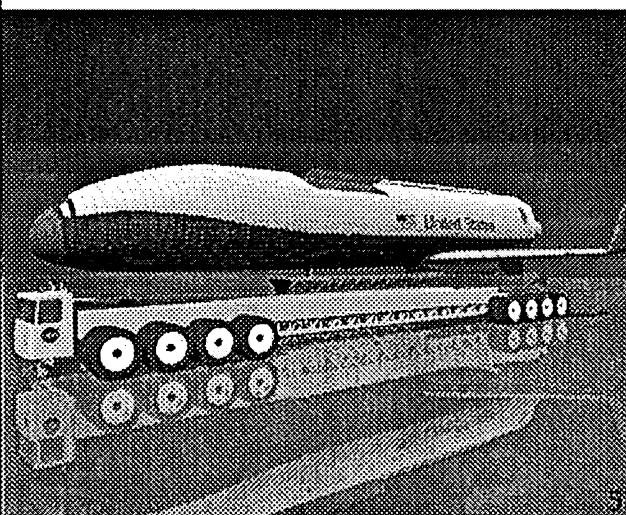
Vertical Landing SSTO



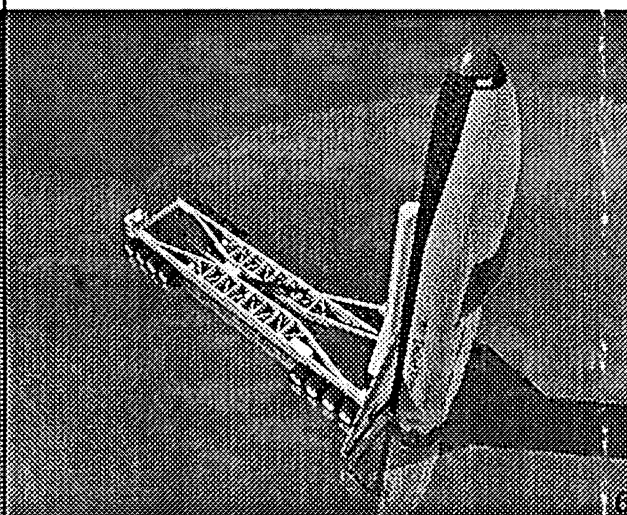
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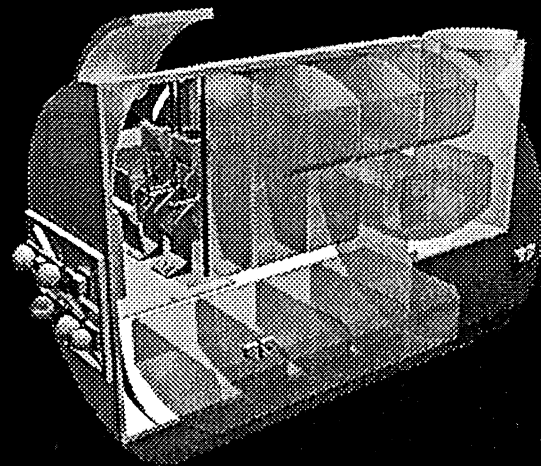
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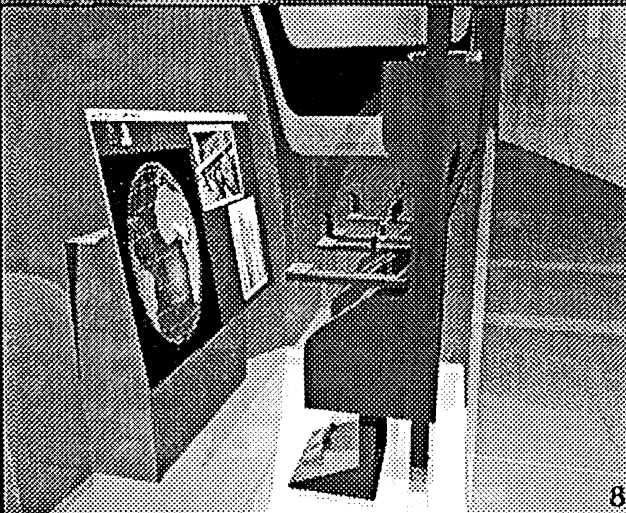
5



6



7



8

Photo-realistic Images:

- 1) 4 View Lift Body SSTO
- 2) 4 View Winged SSTO
- 3) 4 View Vertical Landing SSTO
- 4) Winged SSTO Tandem
- 5) Winged SSTO Ground Transportation
- 6) Winged SSTO Launch Position
- 7) Horizontal Manned Payload (cutaway)
- 8) Launch Couch (close-up)

Figure 2 Photo-realistic Images

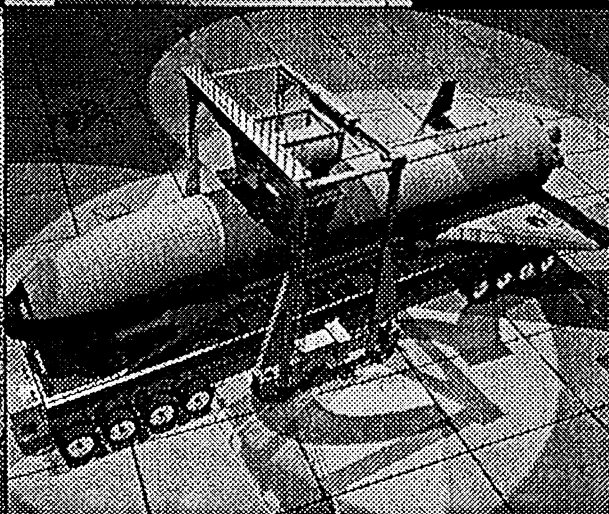
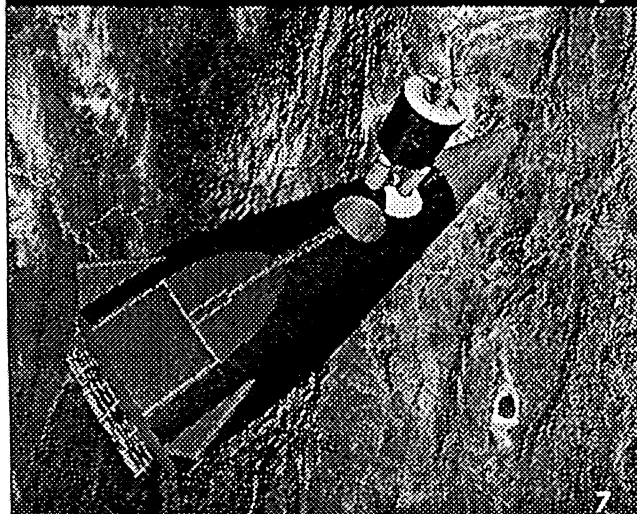
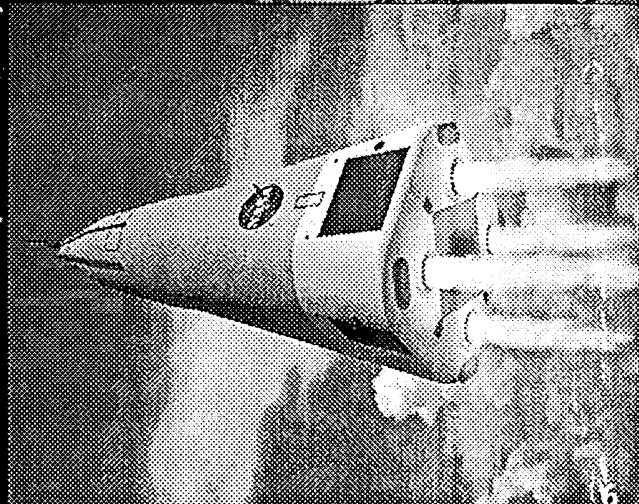
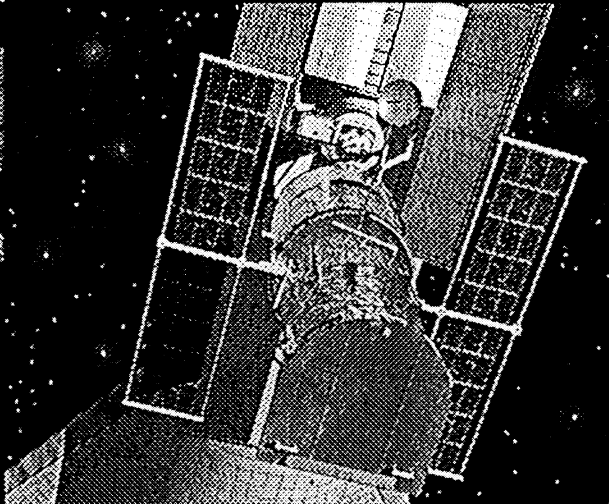
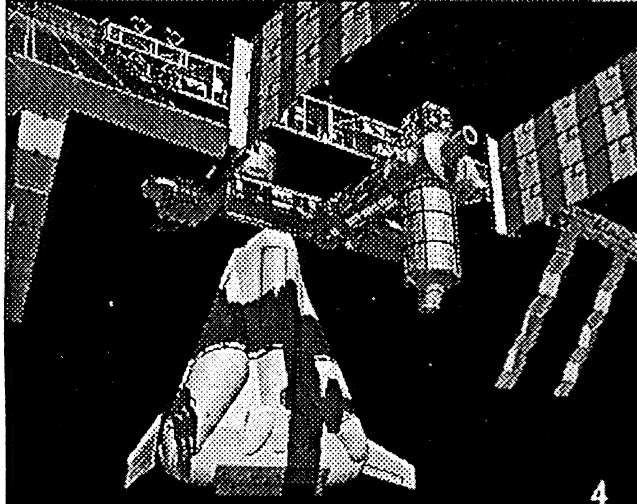
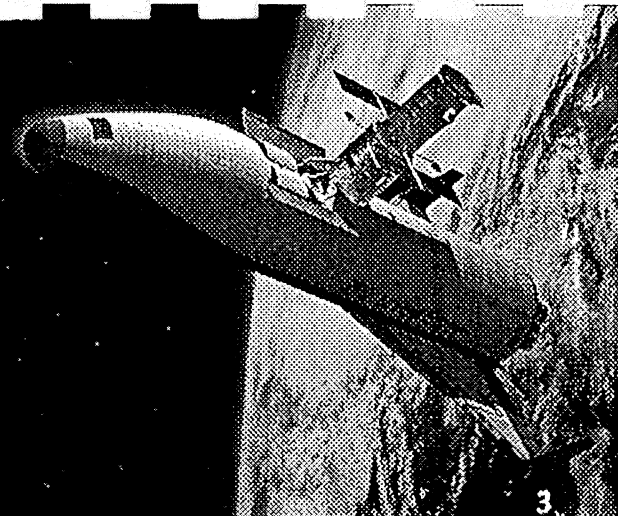
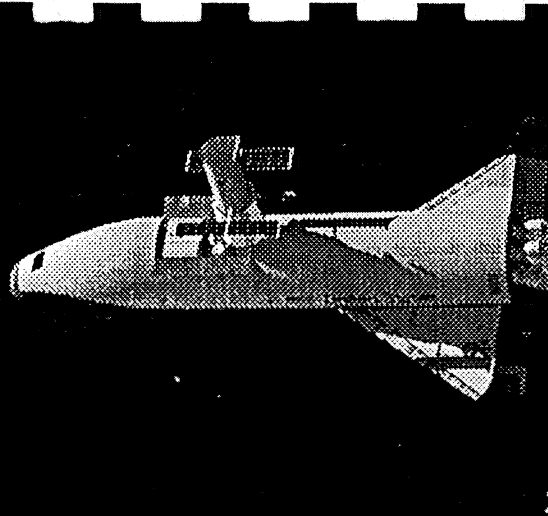
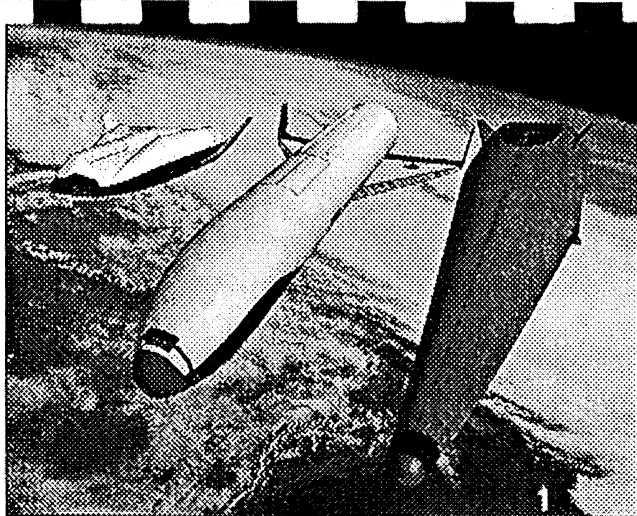


Photo-realistic Images:

- 1) Troika
- 2) Winged SSTO Hubble Repair 1
- 3) Winged SSTO Hubble Repair 2
- 4) Lockheed Lift Body SSTO at Station
- 5) Winged SSTO Hubble Repair Close-up
- 6) DC-X Liftoff (Aerospace America Cover)
- 7) DC-3 Satellite Repair mission
- 8) Winged SSTO Cargo Loading

Figure 2 Photo-realistic Images

2.4.4 Task Summary

This research, design and development effort has produced multiple photo-realistic images that will provide NASA the visual tools to aide in describing and evaluating various concepts of the SSTO RLV Program.

3.0 SUMMARY

This final report has addressed critical issues with relation to Reusable Launch Vehicle Development Research. Future studies will expand the research areas, and in some cases, go into more detail in areas that have been addressed in this initial study.

APPENDIX A

AEROSPACE STATES ASSOCIATION

SLATE OF CANDIDATES

Approved by the Executive Committee
November 23, 1994

CHAIR

The Honorable Gail Schoettler
Lt. Governor-elect of Colorado

VICE-CHAIR (Political)

The Honorable Scott McCallum
Lt. Governor of Wisconsin

VICE-CHAIR (Non-Political)

The Honorable Casey Luna
Lt. Governor of New Mexico (retiring)

SECRETARY

George French of Wisconsin

ASSISTANT SECRETARY

Don Scott of Ohio

TREASURER

Bob Triplett of Oklahoma

ASSISTANT TREASURER

Stephanie Wright of Delaware

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Hon. Gail Schoettler (CO)
Hon. Scott McCallum (WI)
Hon. Casey Luna (NM)
George French (WI)
Bob Triplett (OK)
Jim McGovern (AL)
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**Aerospace States Association
Executive Committee
Conference Call
Wednesday, November 23, 1994
2:00 PM**

Attending were: Secretary George French, Wisconsin; Executive Director Jim Pagliasotti, Colorado; Jim McGovern, Alabama; Treasurer Bob Triplett, Oklahoma; Chairman Casey Luna, New Mexico; Kathleen Connell, Policy Director; Edward Ellegood, Florida; and Vice Chairman Jack Coghill, Alaska

Secretary French (WI) called the meeting to order.

Executive Director Pagliasotti reviewed of the December 1-2, Cleveland meeting agenda.

The nominations for officers were discussed. It was recommended to replace Ed O'Connor with Ron Morris in Florida. Placing Maryland and Virginia on the finance committee was also discussed. A motion was made by Triplett (OK) and seconded by McGovern (AL) that the slate officers be presented at the December meeting.

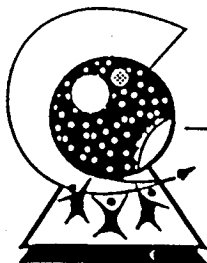
Robert Moorehead, formerly with NASA was accepted as the technical consultant to ASA.

Director Pagliasotti will develop a timetable for contacting new Governors regarding ASA state membership.

Development of an aerospace advisory committee which includes Senators, Congressmen and former NASA officials was recommended. Several possible names were mentioned. It was decided to bring the recommendations to the December meeting where the Advisory Committee will be discussed.

Connell and Pagliasotti reported on their dialog with NASA and that NASA has agreed to host the March meeting in Washington, D.C. at their head quarters. Director Goldin will speak. It was agreed that ASA will accept this offer. The date was tentatively set for March 1-3 but was later changed to March 8-10 to conform with the National Lt. Gov. Conference in Washington, D.C. on March 7-9.

An ASA policy paper was discussed. This paper would lay out the directions ASA believes the space program should take in relationship to state and federal interests. McGovern suggested that this policy could be taken to the political parties for inclusion in their platforms. A policy paper could have significant strategic impact. It was agreed to place this on the agenda at the Cleveland meeting and each member of the Executive Committee was asked to contribute ideas at this meeting. These ideas should encompass agencies, funding, program implementation, tax incentive for the private sector and how all these help implement a coherent U.S. Space Policy.



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SPACE EDUCATION INITIATIVE

IMPLEMENTATION PLAN

by Jim Pagliasotti
303/866-2087
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1. Identify Point of Contact - Coordinator - Project Chair
2. Identify In-state Teachers Who Teach Space in the Classroom
3. Form Space Education Initiative Committee
4. Set Date and Site for Space Education Conference for Teachers
5. Obtain Endorsement of Governor
6. Obtain Endorsement of Interest Groups
7. Obtain Funding
8. Develop Workbook of Space Lesson Plans and Activities
9. Identify Pro-Bono Printer for Workbook Publication
10. Promote Conference
11. Space Education Week
12. Congressional Awards for Space Education Excellence
13. Philosophy
14. Mission

POINT OF CONTACT - COORDINATOR - PROJECT CHAIR

This position is self-explanatory. Someone has to be responsible for coordinating the Space Education Initiative, bringing together the right people to get the job done, keeping them on task, making decisions when no consensus can be reached.

The primary qualification is an interest in the concept and a determination to make it happen. People skills and management skills are a must. Versatility is helpful because, like it or not, some of the team will fail to perform and the coordinator must be able to fill the gaps.

The coordinator will be responsible for implementing all of the required tasks or finding someone to do them. In the Colorado model, I chaired the Committee, did the fundraising, made the arrangements for the Conference facility, lined up the national speakers, kept the books, handled the Conference registration, and acted as MC for the Conference.

TEACHERS

The key to success of the Space Education Initiative (SEI) is the teachers you can bring to the project. SEI, first and foremost, is "by teachers, for teachers." If you can keep that credo in mind, your decision-making process will be greatly simplified.

Too often, you can be distracted by "what we can do for the students." Forget it! SEI is intended to serve teachers, not students. The teachers will decide what works best for their students. Your job is to provide tools for teachers to implement space education in the classroom. If you can get to the teachers, they will get to the students, year after year.

To begin, identify teachers in your state who teach space subjects or themes. Use them to build your contacts with other teachers who teach space or are interested in teaching space. It is critically important that you get their buy-in for SEI.

This group will be the core of your SEI Committee. They should be asked for a commitment to 1) serve on the committee; 2) actively do outreach to other teachers; 3) provide lesson plans or activities for a SEI Space Activities book that you will publish for distribution at the Teacher's Conference; and, 4) present workshops at the Conference.

SEI COMMITTEE

There are two components to the committee: the core group and the community group.

The community group comprises the committee as a whole. It is composed of everybody you can possibly attract from industry, interest groups such as the Alliance for Science, Math and Science Teachers Association, Chamber of Commerce, Business Alliance, Minority Engineering Association, Society of Women Engineers, and so forth. It is your community "buy-in" group, whose primary responsibility is to "credentialize" the project and spread the word. This is not the committee that will get the work done.

The core group are the worker bees. It should be small, well-organized, and active. The core is composed of your key people, mostly teachers, who are the sub-committee chairs, charged with the specific tasks necessary for the SEI to happen.

It is important to realize that teachers, due to the nature of their jobs, are not able to get much done for the project during business hours. They are difficult to reach while they're in the classroom and are hampered by lack of business equipment, such as fax, e-mail, etc. On the other hand, these are the people who are going to make or break the project, so you've got to work within the confines they present.

CORE COMMITTEE SCHEMATIC

Subcommittees should be tasked with meeting the specific needs of a successful SEI project. The Colorado model included Outreach, Fundraising, Workbook, Workshops, Conference, Mailing Lists, Publicity, Student Competition and others as the need occurred. The Chair coordinates the activities of the subcommittees through dialogue with sub-committee chairs.

COMMITTEE TASKS

Endorsements First, you need some credentials. Get project endorsements from the Governor, Lt. Governor, Department of Education, Space Grant Consortium, industry, interest groups, and any others you can think of, particularly women's and minority science/engineering associations. You also will want to ask the governor to proclaim a certain week as "Space Education Week." It should be a month or so after the date of your Conference.

Conference Date Next, set a date and pick a site for the Space Education Conference for Teachers. The date should be during the school week, preferably a Friday or a Monday. It shouldn't conflict with other major education events. It shouldn't be too near a holiday. It shouldn't be too early or too late in the school year. Start eliminating all those dates and the right one will become apparent. There's no perfect date, so do your best.

Site The site will impact your choice of a date, due to the availability of the facility. Factors in choosing a site include location, price, lay-out, staff support, availability of food, audio-visual equipment, and so forth.

You need a meeting room that will accommodate all the attendees for the general sessions, plus breakout rooms in which the workshops will be conducted. Obviously, the size will be determined by how many teachers you attract (you'll get more than you might expect if you did your groundwork) and the capacity of each of the workshop presentations.

The Colorado model attracted 550 teachers, which was no problem in the general sessions but greatly overcrowded the ten breakout rooms. You can solve the problem by limiting registrations to a pre-determined number.

Funding Hey, somebody's got to pay the freight! To address this daunting task, begin by keeping it simple. In Colorado, we did a very elaborate program for approximately \$16,000, plus the Conference registration fees, which averaged a little over \$10 per person.

SEI is designed to be very cost effective. Most of the costs are borne by in-kind contributions, volunteer labor, etc. **Keep it simple by keeping it cheap.** Cash funders appreciate a program that largely pays for itself. In preparing your proposal, add up the value of all the in-kind contributions you expect to receive and create a pie-graph that shows how much of the project already is funded. It's much easier to attract cash donations to a program that is 75% funded up front. Funders want to provide the final piece, not the first piece. They need to know that you are going to get it done with or without them.

Solicit the Department of Defense, the National Guard, NASA, the Space Grant Consortium, industry, foundations. The ideal mix is equal parts federal, state and private sector money. Be certain to wave the Governor's endorsement at them, so they know the state's CEO wants to see SEI happen.

But, remember, the majority of costs will be borne in-kind. Ask the hotel or other conference site you choose to cut their prices to the bone in exchange for listing them as a major contributor. Get exhibitors to contribute to the cost, or, as an alternative, get them to supply lots of hand-outs for the teachers. You need some cash, but there are many kinds of donations that will address your overall needs. Be creative and try to get something useful from everyone you solicit. Cut every cost you can out of the budget through full or partial in-kind donations.

You need a broad spectrum of workshops to attract the largest possible attendance of teachers. Do you need someone to build a workshop around space and geography? Space and music? Do you need more workshops for middle school teachers? Be certain to get a good mix of workshops, covering both the range of subject matter and the range of grades. You can expect the strongest attendance from K-9 teachers and only some 10-15% high school level. Whatever the particular needs, they can be filled by a judicious search through the universities, industry, the Space Education office at NASA, and other such sources for educational outreach.

Next, you need to line up some celebrities. Locally grown astronauts are your best bet. Find out who in the past or present astronaut corps grew up in your state or graduated from a local university. Look for people on your committee or in local industry who know astronauts. Work every angle you can think of that might provide a personal contact with them, because they are busy people with full schedules. They aren't easy to get.

On the plus side, astronauts usually have a serious commitment to education and initiatives such as SEI. If your conference date fits their schedule, they usually try to cooperate.

The traditional approach to scheduling any of the active astronaut corps is via the astronaut office at Johnson Space Center in Houston. Be forewarned that this route is difficult and expensive. They require an open-ended ticket (the most expensive kind) and all travel expenses. Treat this approach as a last resort, used only if you can't get them through personal contacts.

Second tier celebrities would include professional speakers from industry, the Air Force, science museums, the local planetarium, your nearest NASA facility and the Space Grant College in your state. Each of these has specialists in educational outreach to teachers. They can add the bells and whistles to your conference that makes it a dramatic and memorable experience for those who attend.

NOTE: A key consideration in formulating your line-up should be the use of women as role models. The vast majority of K-12 teachers are women. They have been challenged to enhance math and science literacy in their students. Yet, recent evidence indicates that women were systematically steered away from these subjects when they were in school, despite their interest and capabilities.

One motivation for the Space Education Initiative is to provide teachers with a "comfort zone" in which they can explore math and science related subject matter. Exhibiting women who have achieved a high degree of success in aerospace is an important factor in creating that comfort zone.

So, you've now built your line-up for the conference presentations. The next consideration is exhibits. You can find within your state's industry and academic base any number of interesting exhibits on astronomy, robotics, rocketry, and so forth.

It helps to use exhibitors who have some relationship to K-12 education, either through active education outreach programs or, more directly, by lining up text book publishers who stock space-related titles, companies like Estes Rocket Company, which sells to schools, and so forth. Try to find exhibitors who have lots of useful handouts for teachers, even if it is little more than space posters and such. Teachers like freebies.

From all of these folks, presenters and exhibitors alike, you'll need a "presenters" form. For exhibitors, what space will they require, how many display tables, what is the nature of their display, what handouts can they provide, what if anything will they be selling, etc.?

For presenters, a title and full description of the workshop or lecture, the grade levels for which it is intended, the number of people they can accommodate, what materials they have as handouts and whether they need you to handle reproductions (reimburse them for doing their own, if you can---it's easier), what seating arrangement they need (lecture seating or worktables), and, most importantly, what are their audio/visual equipment needs?

Once you've gathered all this information, you can get together with the staff at your conference site and nail down the details: what the conference agenda and the time-line will be, who will speak, where, when, what a/v equipment goes where, etc.

You can print a draft agenda at this point to use for promoting the conference.

PROMOTING THE SPACE EDUCATION CONFERENCE

Can you turn them out? You've already done a hell of a lot of work, which will all be for naught if nobody shows up at the conference. Will anybody attend? That question kept me awake for a month before the Colorado conference.

What I learned in a big way is that teachers really do respond to space education. They want it. We drew 550 teachers from all over the state in the midst of a two-day, state-wide January blizzard. Some of them drove as long as eight hours to be there. It was staggering to me to see the enthusiasm the teachers showed for what we were doing. So, don't worry about it. Do the groundwork well. Once you build it, they will come.

The place to begin is with contacts through your core committee, through the state Department of Education (if they're cooperative: they might view your effort as meddling in their profession, turf battles being what they are. Use the governor's endorsement to leverage some cooperation), and through various interest groups who have mailing lists and newsletters you can use.

The best source of mailing lists are the interest groups who do science and math projects. These include the folks who put on the Science Olympiad, the state math and science teachers associations, the local Alliance for Science, and so forth. Usually, they are generous about sharing their lists. They also are likely to publish newsletters, which you can use to promote the conference. This is particularly likely if you have included them on your SEI committee and gotten their endorsement of the project.

Do not make the mistake of mailing only to principals, superintendents, or school science coordinators. These common contact points for education initiatives are inundated with paper. Most of what they get ends up in the trash can and none of the teachers you are trying to reach ever see it.

SEI is by teachers, for teachers. That concept is the key to getting the attention of the teachers you are trying to attract. It is peer outreach, which teachers respond to. Everybody has a project they are trying to force feed the teaching profession; SEI will work where others won't because it is based on teachers reaching out to other teachers. Avoid the bureaucrats and the administrators by going directly to the source.

Wherever possible, mail your promotional literature to the teachers at their home addresses, as well as at their schools. Hit them from both places. Do more than one mailing, and use every newsletter you can get your hands on. Definitely use e-mail and the internet wherever it is applicable. Remind them as often as you can (limited by common sense and the budget) that the conference is coming and they need to be there.

Tout the astronauts and other "name" presenters, the quality of your workshops, the handouts and other freebies. Remind them that space gets the attention of their students and that you can help make it available in their classrooms.

But, one of the best incentives is to arrange with a local university to provide recertification credit for conference attendance. In Colorado, we were able to offer one hour credit for conference attendance, plus participation in Space Education Week and producing a lesson plan based on the Space Ed Week experience.

Stress the "by teachers, for teachers." Treat them with professional courtesy. Show them respect. This conference is for them. It's a high quality, low cost effort to help them build a space education program in their classrooms.

When the registrations come pouring in (and they will, mostly in the last days before the deadline), you will need to create some sort of checklist to be used when they arrive at the conference.

You also will have decided whether to require them to register for specific workshops, or to let it be a choice they make at the conference on a first come, first serve basis. There are arguments for the more orderly approach, but it requires more staff time. Whichever way you go, you'll get complaints, but they are minor.

SHOWTIME

By now, you've done the night before walk-through of the facility, made sure that everything is where it belongs and is in good working order. Your presenters are on site and ready to go. You may have hosted a dinner for them last night and you've provided nice accommodations for those who've come from out of town. The exhibits are in place. The crew that will handle the check-in of attendees is ready. You have at least one person posted at a table with a large question-mark sign to handle the inevitable "I don't understand this" inquiries.

What's next? You'll have a long table of coffee, tea, juice and donuts or pastries for the registrants. You'll have bags (supplied by an industry donor) pre-stuffed with the complete and final agenda, workshop descriptions, map of the premises including the breakout rooms, the workbook you published and whatever other handouts fit to give the teachers when they check-in.

Next, you'll move them into the ballroom (or wherever the general sessions are held) and you're underway. Rather than speculate on what sort of show you'll put on, I've included the agenda from the Colorado model as a guide you can use. The one thing I can assure you of is that it will be an exhausting and exhilarating day for everyone.

SPACE EDUCATION WEEK

The teachers who attended your conference need an opportunity to put what they've learned into practice. A formal proclamation by your governor of Space Education Week during a certain time you designate is the most effective vehicle for creating a continuum of your efforts.

Space Education Week will be a time during which teachers all over the state use some or all of their classroom time to focus on space education. They may use one of the lesson plans on building a Martian Colony, for instance, as a class project, or they may design some sort of class competition in art; whatever the choice, having a designated week where everyone participates will help teachers follow through with the tools you have provided.

If you want to greatly add to your work load, you can feature some sort of state-wide space education competition, which involves district, regional and state judging, prizes and all manner of hoopla. We did it in Colorado and it struck me as more hassle than it was worth.

CONGRESSIONAL AWARDS FOR SPACE EDUCATION EXCELLENCE

A better alternative, I believe, is to create a competition that can be entered via essay or video tape. Teachers can relate their experience in space education, submit it to the SEI chair, and the winning submittal can be honored with a cash prize presented by your local congressional representative or senator.

This establishes a tie with Congress, rewards innovative teachers, and keeps the problems associated with a state-wide competition to a minimum.

The award could be called the Pat Schroeder (or David Obey, or Jeff Bingaman, or whomever) Award for Space Education Excellence. It can be "made possible through the generosity of (donor)" in the amount of \$1000 for the winning teacher to use as he/she sees fit.

Ideally, the congressional namesake should be on hand during the Space Education Conference to announce the competition and the prize. A brief speech about his/her commitment to excellence in education can precede the announcement. This will require that you sell the idea to somebody in your congressional delegation and that you schedule the Conference at a time when Congress is in a district work period or in recess.

PHILOSOPHY

The Space Education Initiative (SEI) is a broad-based, state-wide effort to make the mystery and excitement of space adventure an integral part of a student's learning experience. It is focused on and structured to assist the classroom teacher in becoming comfortable with space as a multi-disciplinary subject for use in gaining and retaining the attention of students.

MISSION

To instill space education in every school in your state by the year 2000.

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Memorandum

TO: Aerospace States Association

FROM: Janice M. Bellucci *JMB*

SUBJECT: Expected Committee Changes in the 104th Congress

The purpose of this memorandum is to provide you with a report on the membership changes expected to occur on key congressional committees as a result of the elections on November 8. The attached documents offer a projected look at the composition of these committees in the 104th Congress. The final rosters will not be determined until House and Senate party leadership elections are held and the new committee leaders select their committee members.

As a result of the elections, the Republican party won control of both the Senate and the House of Representatives. It is the first time in 40 years that the Republicans have controlled both houses of Congress.

U.S. Senate

The Republican party gained a total of eight seats in the Senate on election day, one more than the minimum required in order to obtain control of the Senate. After the elections, a party switch by Sen. Richard Shelby (R-AL) increased the new majority to a total of 53 Republican versus 47 Democrats in the Senate.

The Republican control of the Senate will result in changes at every leadership position as well as in the chairmanships and rosters of every committee and subcommittee. The final details of these changes will not be known until after the Senate Republican leadership elections to be held December 2.

Appropriations Subcommittee

Sen. Barbara Mikulski (D-MD), the current chairman, is expected to remain on the VA-HUD-IA appropriations subcommittee in the position of ranking minority member. However, the

current ranking minority member -- Sen. Phil Gramm (R-TX) -- is expected to leave the subcommittee in order to chair the Senate Banking Committee.

This leaves Sen. Alfonse D'Amato (R-NY) or Sen. Don Nickles (R-OK) as possible successors to the chairmanship. However, Sen. Nickles is rumored to have an interest in leaving the committee to join the Senate Finance Committee. Thus, it is also possible that Sen. Christopher Bond (R-MO) could take the chair.

Membership on the subcommittee will change significantly. The number of Republican members of the subcommittee will increase while the number of Democratic members will decrease. As a result, Sens. Bob Kerrey (D-NE) and Dianne Feinstein (D-CA) may not return to the subcommittee.

The staff who serve the Senate VA-HUD-IA subcommittee will also change. Majority clerk Kevin Kelly will be replaced, possibly by minority clerk Stephen Kohashi. Kelly is not expected to remain with the subcommittee; he will either accept a staff position assisting Sen. Mikulski in her duties as Democratic Conference Secretary or move into the private sector. Kohashi may not be selected as majority clerk due to friction with the office of Sen. Bond.

Authorization Subcommittee

Sen. John Rockefeller (D-WV), current chairman of the Science, Technology, and Space subcommittee, is expected to continue his service as ranking minority member. Sen. Conrad Burns (R-MT), current ranking minority member, is expected to be selected as the new chairman of that subcommittee.

Membership in the authorization subcommittee will change with an increase in the number of Republicans (from 4 to 5) and a decrease in the number of Democrats (from 5 to 4). It should be noted that all Democratic members of the Senate subcommittee who faced re-election, including Sen. Charles Robb (D-VA), were successful.

U.S. House of Representatives

The Republican party gained a total of 52 seats in the U.S. House of Representatives, 12 more than the 40 required for them to attain control of the House. As a result, the leadership and composition of the NASA appropriations and authorization subcommittees will change significantly.

The House Republican leadership elections are currently ongoing and the results should be known by December 2 at the latest.

Appropriations Subcommittee

Rep. Jerry Lewis (California), the current ranking Republican, is expected to assume the chairmanship of the VA-HUD-IA appropriations subcommittee. The current chairman, Rep. Louis Stokes (D-OH), is expected to remain on the subcommittee as ranking minority member.

The composition of the appropriations subcommittee will change significantly as the number of Democrats is reduced (from 6 to 3) and the number of Republicans is increased (from 3 to 6). None of the Democratic members of the subcommittee failed in their re-election efforts. However, Rep. Dean Gallo (R-NJ) retired, leaving four slots to fill on the Republican side.

The staff who serve the House VA-HUD-IA subcommittee will also change. Paul Thompson, now majority clerk, will be replaced due to the Republican success. It is reported that Jeff Lawrence, current NASA Associate Administrator for Legislative Affairs, may return to Congress in order to assume that position.

Authorization Committee

Rep. George Brown (D-CA), currently chairman, has expressed a desire to continue serving on the House Committee on Science, Space and Technology. If he is allowed to continue, he is expected to serve as ranking minority member. It is reported that he may not be allowed to continue his service because under his leadership the Committee only enacted three pieces of legislation this year.

Rep. James Sensenbrenner (D-WI) may assume the position of full committee chairman if Rep. Robert Walker (D-PA) wins his bid on Nov. 5 to be the next House Majority Leader. Should Walker lose his race for that position, he is expected to become the chairman of the House Science Committee.

Significant changes in the composition of the committee will occur in the 104th Congress. Seven Democrats on the committee lost their re-election races: Peter Barca (D-WI), Eric Fingerhut (D-OH), Dan Glickman (D-KS), Jay Inslee (D-WA), Don Johnson (D-GA), Herbert Klein (D-NJ), and Dick Swett (D-NH). In addition, five Democrats either retired or ran for Senate, for a total of 12 Democrats leaving the committee.

Furthermore, to reflect the Republican majority in the House, the committee's party membership will be adjusted to a 54%-46% ratio of Republicans to Democrats.

Six incoming representatives have already expressed a primary preference to join the House Science Committee in the 104th Congress: John Shadegg (R-AZ), Andrea Seastrand (R-CA), David Funderburk (R-NC), Zach Wamp (R-TN), Steve Stockman (R-TX), and Lloyd Doggett (D-TX). Seastrand's district includes Vandenberg Air Force Base and Stockman's includes NASA Johnson Space Center. Both could win seats on the House Space Subcommittee.

Authorization Subcommittee

Rep. Ralph Hall (D-TX), currently chairman, is expected to remain on the House Space Subcommittee in the position of ranking minority member. Rep. Dana Rohrabacher (D-CA), an ardent supporter of the DC-X SSTO program, is expected to assume the position of subcommittee chairman. However, if Rep. Walker assumes the chairmanship of the full Science Committee, Rep. Sensenbrenner may become the Space Subcommittee chairman.

It is reported that the Republican leadership may choose to significantly change the duties of this subcommittee, perhaps merging it with another subcommittee. However, the subcommittee is not expected to be disbanded due its duties on the NASA authorization bill.

Three Democratic members will leave the House of Representatives in the 104th Congress: Dave McCurdy (D-OK), Jim Bacchus (D-FL), and Eric Fingerhut (D-OH). More are expected to leave the subcommittee as the Republicans adjust the party ratio in their favor.